DOE National Laboratories and Universities:

Building the Workforce of Tomorrow

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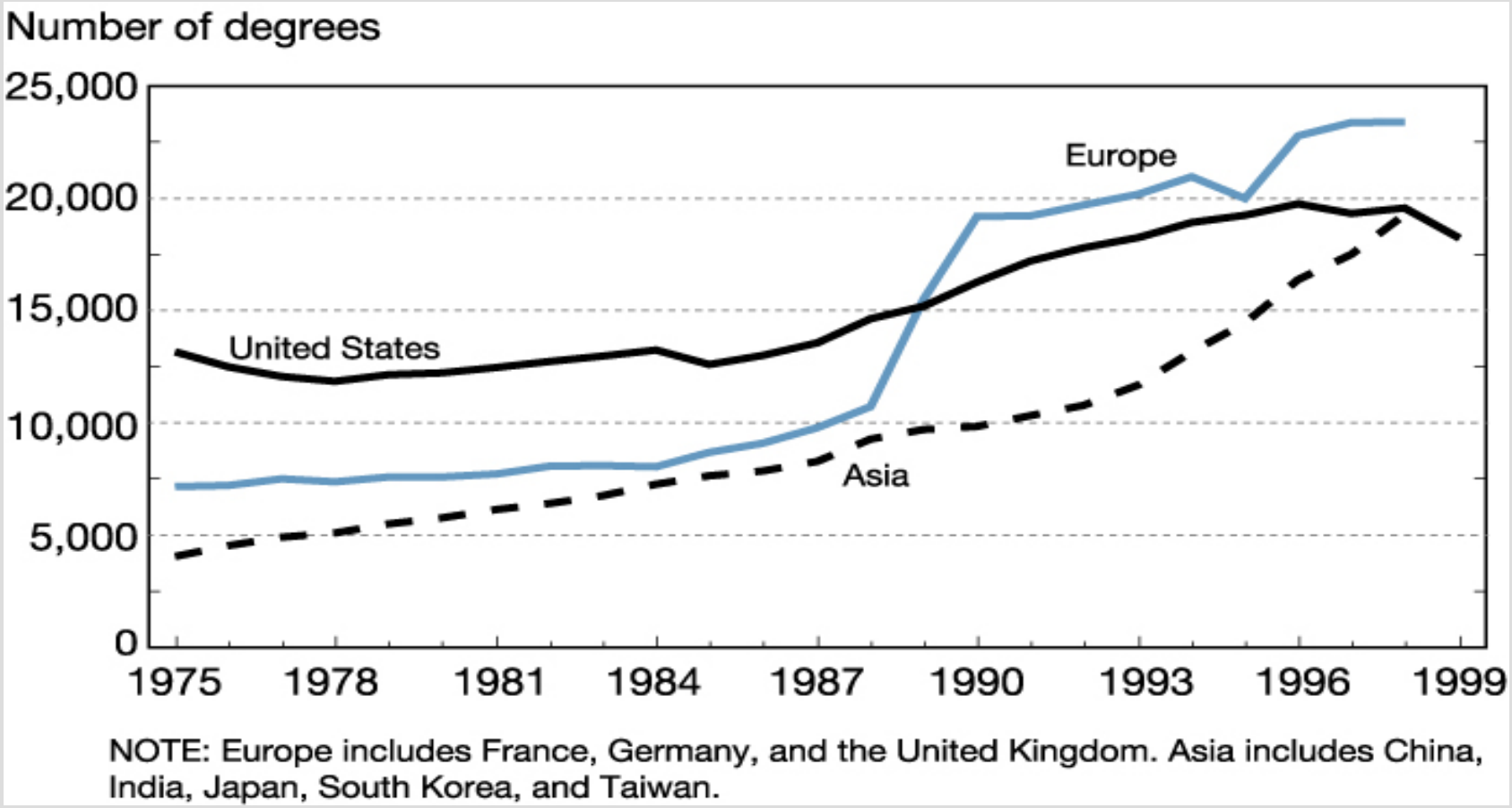
"Building a vital S&E workforce is critical to our nation's future"

- There is broad national concern about the state of our S&E workforce
  - Aging of the existing workforce and strength of the pipeline
  - Dependence on foreign nationals
  - Curriculum and training experiences designed to meet our national needs – e.g., multidisciplinary teams
- The resources required to develop the next generation of scientists and engineers are tougher to get
  - Federal research budgets are in decline
  - The pace of scientific advance is accelerating
  - Impacts DOE as well as universities
- Both DOE laboratories and universities are exploring new mechanisms and opportunities to develop and attract new scientists and engineers to their research teams

Global Context: Natural Sciences and Engineering Doctoral Degrees 1975-2000:

U.S. Stagnant, Europe and Asia Surge

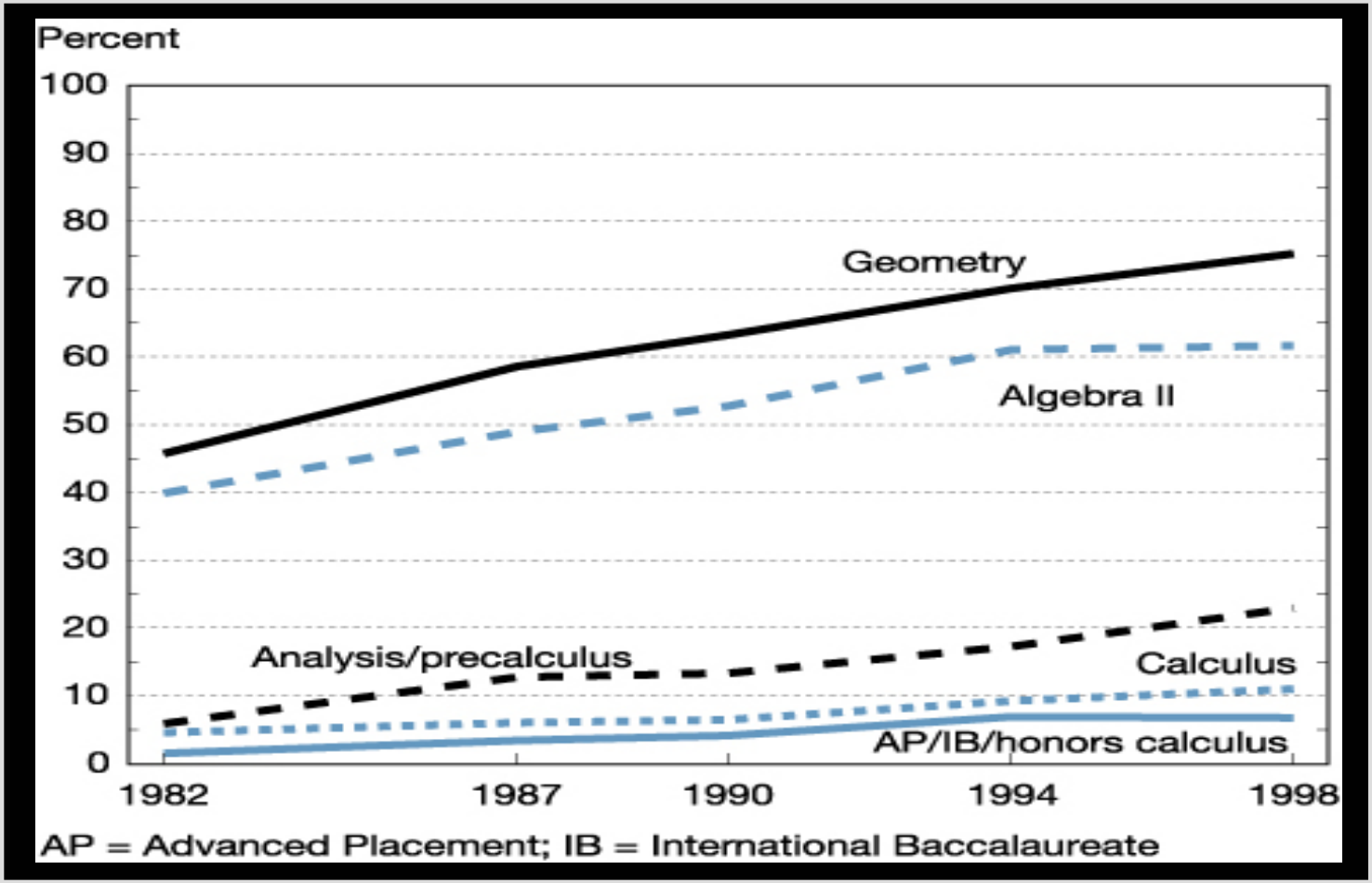


Source: Science & Engineering Indicators 2002

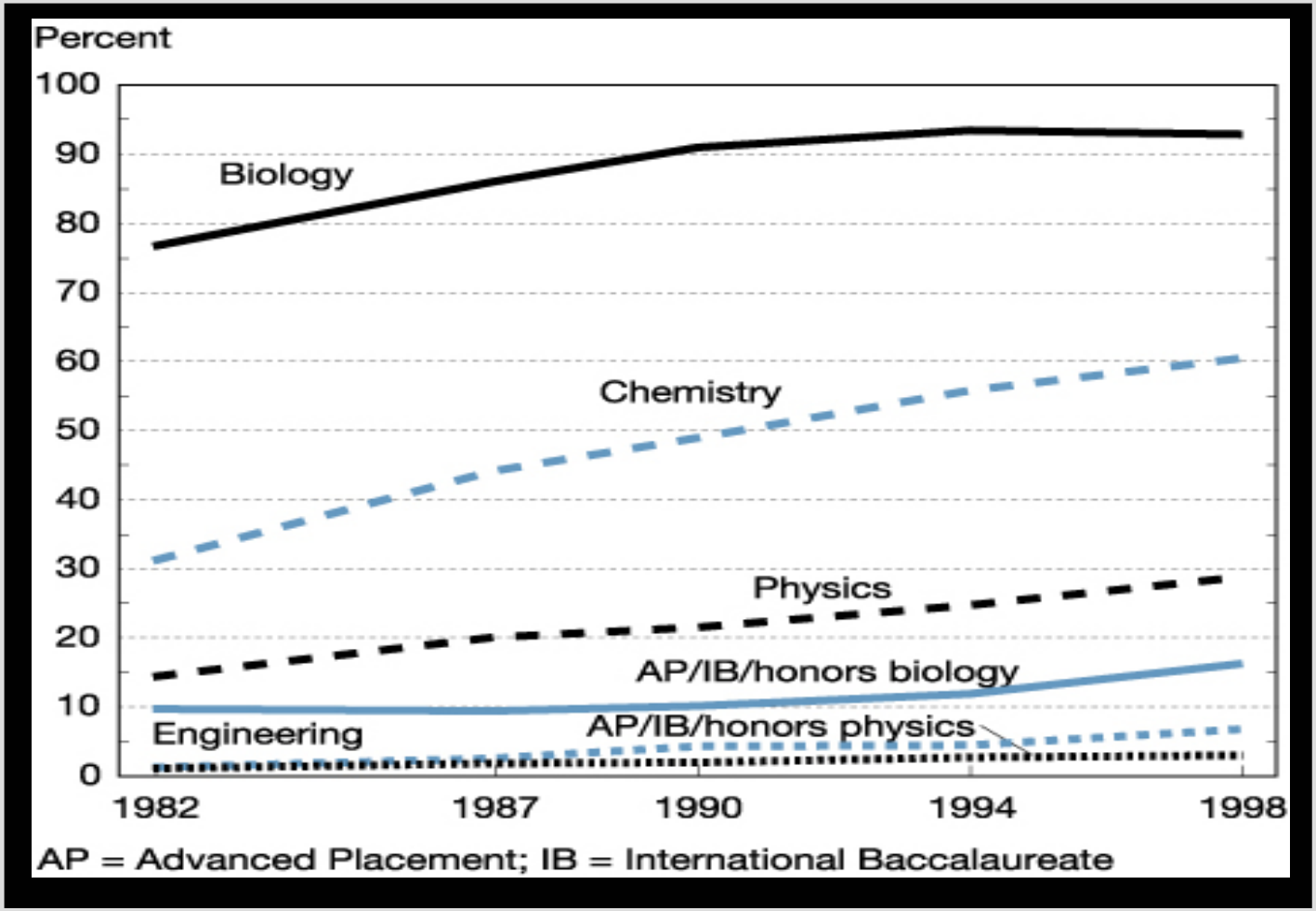
What about Science and Math Preparation at High School and Undergraduate Levels?

Let's look at the pipeline…..

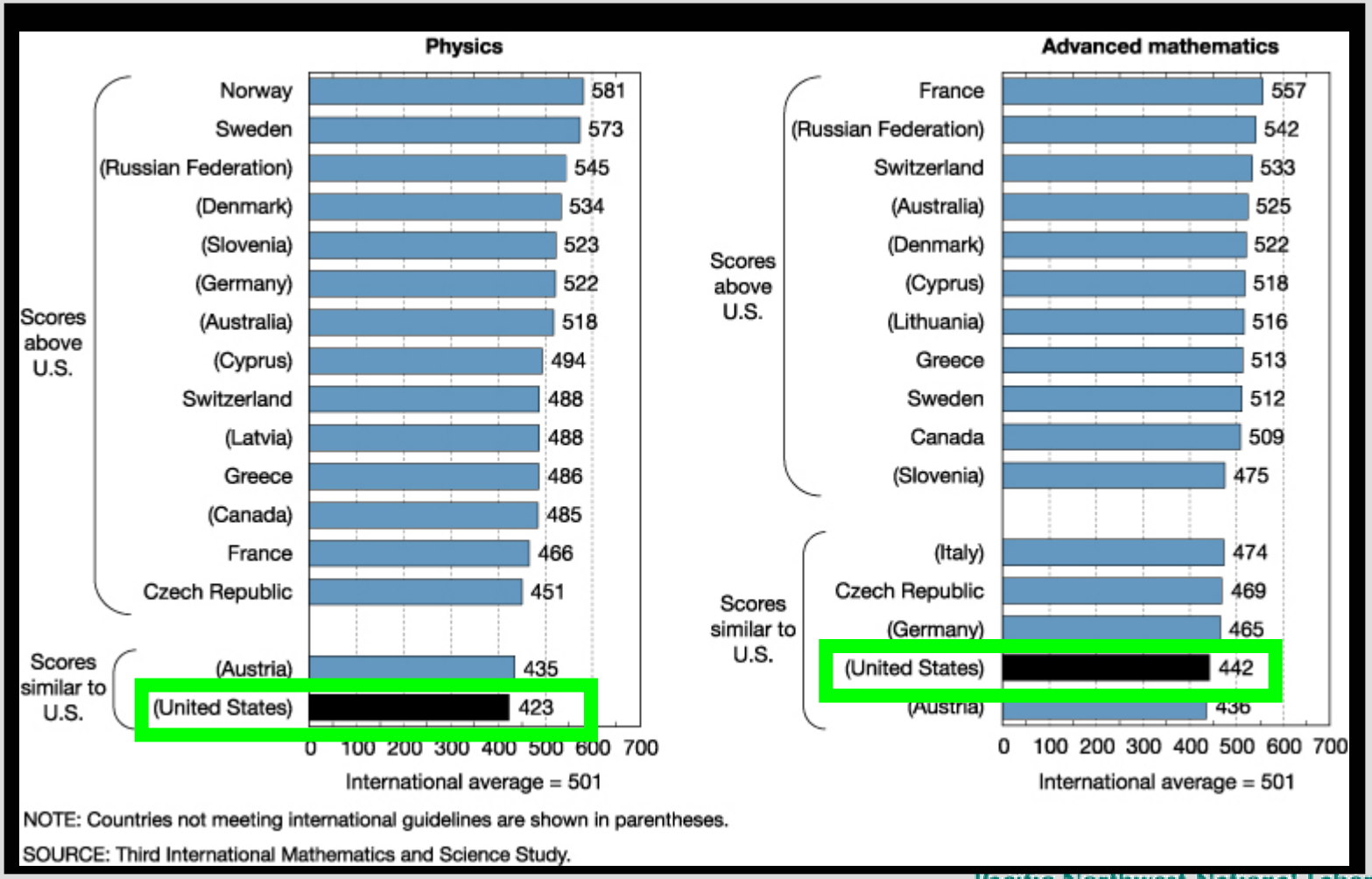
Percentage of high school graduates who took selected mathematics courses:
1982, 1987, 1990, 1994, and 1998



Percentage of high school graduates who took selected science courses:
1982, 1987, 1990, 1994, and 1998



Average scores on physics and advanced mathematics assessment for students in the final year of secondary school: 1994-95



Where Does the Department of Energy Fit In?

The Department of Energy is a Science Agency

Top Five Government Research Organizations for:*

Physical Sciences	Earth and Environmental Sciences	Mathematics & Computing	Engineering	Life Sciences	R&D Facilities
1. Energy (2,012)	1. NASA (1,051)	1. DOD (657)	1. NASA (1,948)	1. HHS (11,838)	1. Energy (939)
2. NASA (1, 019)	2. NSF (481)	2. Energy (623)	2. DOD (1,837)	2. USDA (1,215)	2. NASA (403)
3. NSF (515)	3. DOD (383)	3. NSF (399)	3. Energy (851)	3. DOD (519)	3. DOD (386)
4. DOD (412)	4. INTERIOR (364)	4. HHS (127)	4. NSF (484)	4. NSF (403)	4. NSF (271)
5. HHS (205)	5. Energy (335)	5. COMMERCE (89)	5. TRANS (323)	5. Energy (288)	5. HHS (227)

** Numbers are FY 1999 Dollars in Millions - Source: NSF -- Preliminary Federal obligations for research, by agency and field of science and engineering: fiscal year 1999*

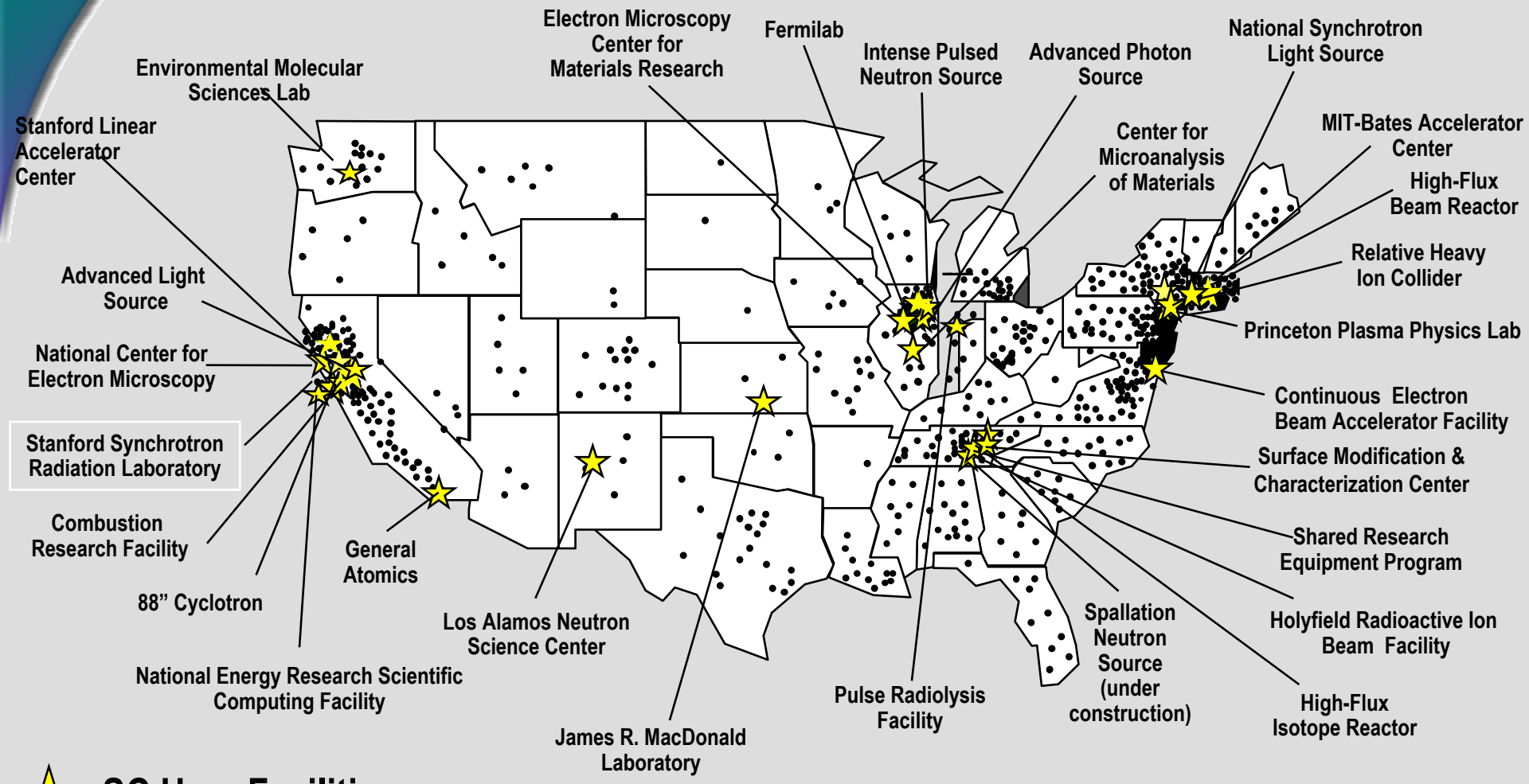
*** Numbers are FY 1999 Dollars in Millions - Source: OMB*

DOE is a Key Player in Developing our Nation's S&E Talent

- Scientific user facilities and related operational support
- Research programs – DOE funded
  - Opportunities for high school, undergraduate and graduate levels
  - Post-doctoral positions
  - University professors and laboratory scientists as integrated research teams
- Education and workforce development programs
  - Historically, DOE spent about $60M annually on science and engineering education programs, primarily through Office of Science
  - Congress cut this to $20M in the late 90s and eventually zeroed out.
  - Since 2000, this program has been rebuilt to about $6M with a focus on undergraduate programs and pre-college outreach (primarily Science Bowl)
  - Future plans target enhancing graduate level activities, with a new program in workforce development for both students and teachers
- Internal DOE laboratory investments

DOE User Facilities Provide Unique Opportunities for Research and Learning

DOE Office of Science Scientific User Facilities and the Universities That Utilize Them

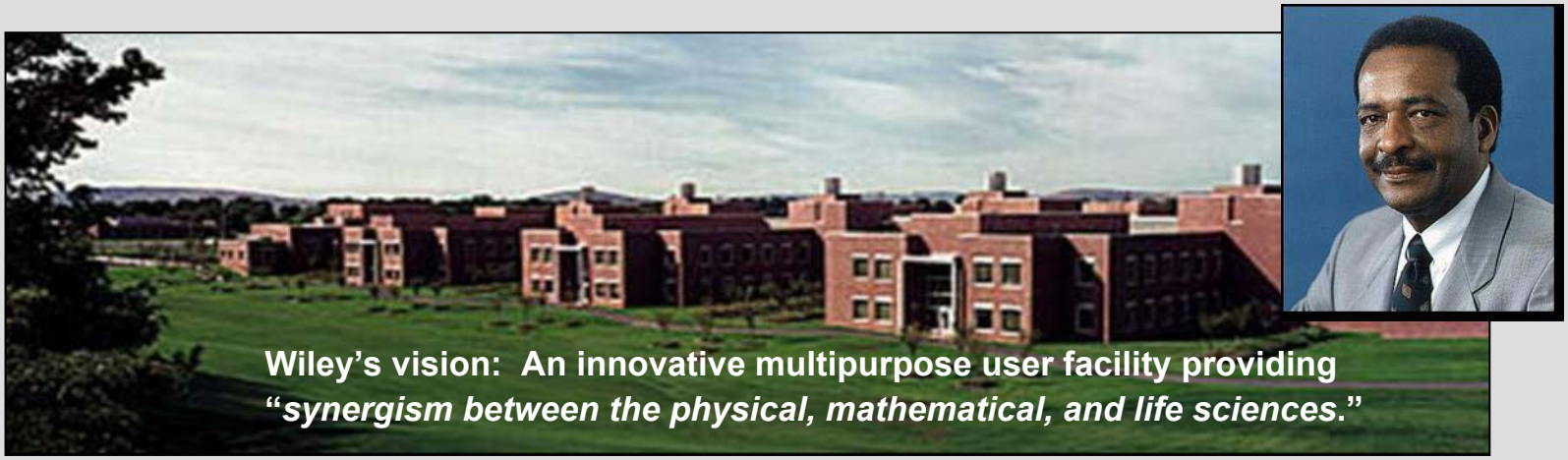


★ SC User Facilities

● Universities that Use SC Facilities

50% of Facility Users are University Researchers

The Environmental Molecular Sciences Laboratory: A National User Facility



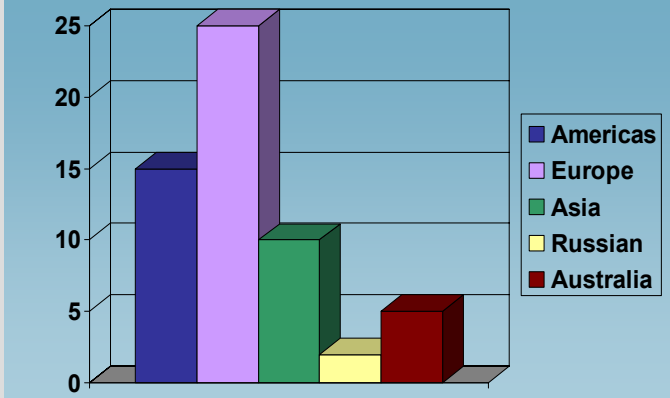
- **EMSL's Mission**
  - Provide advanced resources to the scientific community.
  - Conduct fundamental research in molecular and computational sciences in support of DOE missions.
  - Educate scientists in molecular and computational sciences.
- **Signature Characteristics**
  - Integration of theory, modeling, and simulation with experiment.
  - Multidisciplinary teams and collaborative mode of operation to solve major scientific problems of interest to DOE and the nation.
  - Teams who develop extraordinary tools and methodologies.

Extraordinary Tools and Staff

- **EMSL Facilities**
  - Chemistry and Physics of Complex Systems
  - Environmental Spectroscopy & Biogeochemistry
  - High Field Magnetic Resonance
  - High Performance Mass Spectrometry
  - Interfacial & Nanoscale Science
  - Molecular Science Computing
- **Support**
  - Computer and Network Services
  - Instrument Development Laboratory
  - User Services & Outreach

EMSL User Demographics

International Use (FY01)



- 5500 users (FY98-02)
- 2000 user projects (FY98-02)

- US Universities
- US Industry
- Other Government Labs

United States Use (FY01)

PNNL Programs Focused on Education and Learning

- K-12
  - Bringing science to life at local high schools
  - Mentoring students
- Undergraduate
  - Discovering what science and engineering can offer
  - Teaming with university departments to keep students engaged
- Graduate and post-doc
  - Expanding experience base and job opportunities for graduates
  - Building interdisciplinary approaches and team skills
- Adjunct faculty and joint appointments
- Strategic university partnerships targeting new fields
  - Nanoscience and nanotechnology
  - Systems biology
  - Bioinformatics

Enhancing the Learning Experience of Students Through Experimentation

The High Field Magnetic Resonance Facility provides state-of-the-art nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) instrumentation for determining molecular structures that impact environmental remediation and biological health effects.

- **Virtual NMR capability to enable use and collaboration with EMSL scientists by remote users – utilized by professors in chemistry classes across the country**
- **Classroom studies complemented by real-time visits and experiments conducted at EMSL**
- **Integrating theory with experimentation – using state of the art tools and techniques**

Enabling Growth of University Programs

- **Berkeley grad student recruited by WSU and PNNL**
  - PNNL provided lab space, research funding, mentoring
  - WSU provided support for the new assistant professor – now this individual is a full professor of physics, building new research programs
  - An environment that allowed him to create new capabilities made it possible

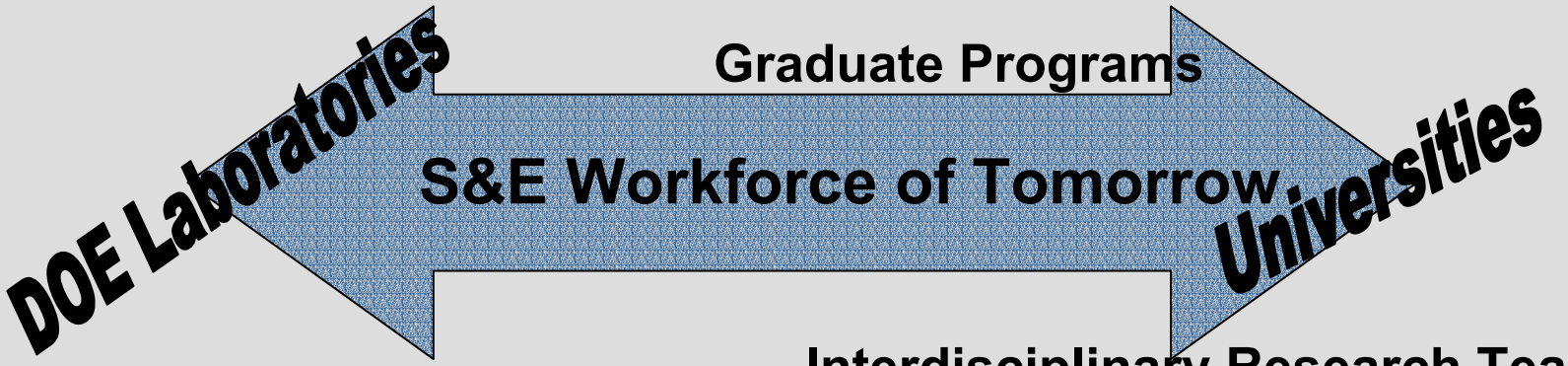
Advancing Women and Minorities in Science

- Student Research Apprentice Program
  - Hispanic woman, first in family to go to college
  - First experience with PNNL through high school program
  - Mentors at PNNL supported her goals to go to college
  - DOE programs provided her the opportunity to return to the lab every summer
  - Graduated recently from WSU; now working as a scientist at the laboratory
  - Planning on continuing her education with an MS in chemistry

We Have Shared Goals for Development of a Talented S&E Workforce

K-12 Pipeline

Undergraduate Education



Interdisciplinary Research Teams

Faculty Positions

Entrepreneurial Opportunities

We Need to Extend the Impact and Reach of our Partnerships

- Revitalization of the DOE workforce development programs
  - Students, teachers and laboratory mentors
  - Travel support for students and professors is critical
- Mechanisms in universities to recognize the value of experience with research teams and multidisciplinary problem-solving
- More opportunities and support for universities and laboratories to work together to grow new programs at the cutting edge of science
- Facilitate and support the process for joint appointments and sabbaticals
- And yes, this will take additional resources….based on a new value proposition of mutual goals and reward